BRH/BBE 70-8

PB 197 872

Diagnostic Radiation Utilization in Selected Short-Term General Hospitals

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
Springfield, Va 22151

LIST OF PUBLICATIONS

Technical reports of the Division of Biological Effects, Bureau of Radiological Health, are available from the National Technical Information Service, Springfield, Va. 22151. The price for paper copy from NTIS is $3.00 for reports of less than 300 pages. Microfiche is $0.95. Prices are available from NTIS for bulk orders. When ordering from NTIS, the PB number should be cited if indicated.

PHS 1672 — Radiological Health Research, Summary Report, July 1965 - December 1966 (PB 183 795)

PHS 1809 — Radiation Bio-Effects Summary Report, January - December 1967 (PB 183 796)

PHS 1809 — Radiation Bio-Effects Summary Report, January - December 1968 (PB 183 797)

TSB 68-4 — Biological Aspects of Microwave Radiation - A Review of Hazards (July 1968)(Reprinted August 1969) (PB 185 964)

DBE 69-1 — Biological Aspects of Laser Radiation - A Review of Hazards (January 1969) (PB 184-003)

DBE 69-2 — Evaluation of a Possible Causal Relationship between Fallout Deposition of Strontium 90 and Infant and Fetal Mortality Trends (October 1969) (PB 188 974)

BRH/DBE 70-1 — Radiation Bio-Effects Summary Report, January - December 1969 (PB 190 110)

BRH/DBE 70-2 — Biological Effects and Health Implications of Microwave Radiation (June 1970) (PB 193 898)

BRH/DBE 70-3 — Biological Aspects of Ultraviolet Radiation - A Review of Hazards (September 1970) (PB 194 611)

BRH/DBE 70-4 — Doses to the Central Nervous System of Children Resulting from X-Ray Therapy for Tinea Capitis (October 1970) (PB 195 967)

BRH/DBE 70-5 — A Review of Radium Toxicity Studies (December 1970) (PB 196 992)

BRH/DBE 70-6 — Radiation Incidents Registry Report 1970 (December 1970)

BRH/DBE 70-7 — Radiation Bio-Effects Summary Report, January - December 1970

BRH/DBE 70-8 — Diagnostic Radiation Utilization in Selected Short-Term General Hospitals (December 1970)

BRH/DBE 70-8

Diagnostic Radiation Utilization in Selected Short-Term General Hospitals

Fay M. Hemphill, Ph.D.
Frances B. Locke, M.S.
Rudolph D. Hesselgren
Division of Biological Effects

December 1970

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Bureau of Radiological Health
Rockville, Maryland 20852

FOREWORD

The Bureau of Radiological Health conducts a national program to limit man's exposure to ionizing and nonionizing radiations. To this end, the Bureau (1) develops criteria and recommends standards for safe limits of radiation exposure, (2) develops methods and techniques for controlling radiation exposure, (3) plans and conducts research to determine health effects of radiation exposure, (4) provides technical assistance to agencies having radiological health programs, and (5) conducts an electronic product radiation control program to protect the public health and safety.

The Bureau publishes its findings monthly in Radiological Health Data and Reports, appropriate scientific journals, and from time to time in Division-sponsored technical reports.

The technical reports published by the Division of Biological Effects contain information generated by the Division staff which is timely and useful to the radiological health program. Subjects covered by these reports are varied, for the Division is charged with developing--through animal investigations and population studies--knowledge of the biological effects of radiation delivered to man from his environment and from his use of substances and devices that emit radiation. The reports are distributed to persons and repositories that have expressed an interest in the biological effects of radiation; in addition, the reports are available from the National Technical Information Service.

Readers are encouraged to report omissions or errors to the Bureau. Additional comments or requests for further information are also solicited.

John C. Villforth
Director
Bureau of Radiological Health

PREFACE

Medical radiation produces a substantial portion of the total radiation exposure of the population. Because of our concern with radiation exposure and possible biological effects, it is important to determine the trends of radiation exposure. In this study, data on hospitalized patients were analyzed to *determine trends* of specific types of diagnostic radiation, and to study patterns of radiation utilization by hospital size, age of patient, and diagnosis.

The data show a small but steady yearly increase in diagnostic medical radiation for the hospitals in this study, but this does not necessarily apply to all hospitals in the United States. Further analyses of hospital data are planned to explore certain aspects of the utilization trends and patterns discussed here.

William A. Mills

William A. Mills, Ph.D.
Director
Division of Biological Effects

ACKNOWLEDGEMENT

The authors gratefully acknowledge the advice and information from Dr. Vergil Slee and Mr. William Ferguson, of the Commission on Professional and Hospital Activities, on elements and intricacies of the source data; encouragement to pursue the studies from Dr. Charlotte Silverman, Chief, Epidemiologic Studies Branch, Division of Biological Effects, Bureau of Radiological Health; suggestions from viewpoints of a radiologist by Eugene Saenger, M.D., Radioisotope Laboratory, Cincinnatti General Hospital, Cincinnati; support from our statistician associate, Mr. Alan Hoffman; advice and suggestions from members of the Editorial Committee of the Bureau of Radiological Health, especially the editorial guidance of Mr. Donald M. Hodge.

CONTENTS

	PAGE
FOREWORD	iii
PREFACE	v
ACKNOWLEDGMENT	vi
BACKGROUND AND OBJECTIVES	1
SCOPE AND SOURCE OF STUDY DATA	2
METHODS OF STUDY	3
FINDINGS	5
Discharge Distribution	5
Overall Rates	6
Diagnostic Radiation Categories	6
Hospital Size	6
Age of Patients	8
Diagnosis	9
Effects of Adjustment of Separate and Joint Variables	10
Combinations of DRC	11
Within-Year Variation	13
Comparison of Study Hospitals with Non-Study Hospitals	13
SUMMARY AND DISCUSSION	15
Trends of Utilization	15
Patterns of Utilization	16
Utilization of Combinations of DRC	16
Miscellaneous	17
REFERENCES	50
APPENDIX A - DIAGNOSIS GROUPINGS	51
APPENDIX B - APPROACHES TO UTILIZATION RATE CHANGES	52

TABLES

1.	Distribution and Average Age of Discharges by Hospital Size	19
2.	Percent Distribution of Discharges by Age	20
3.	Distribution and Average Age of Discharges by Diagnosis	21
4.	Rates of Any Diagnostic Radiation and Total Diagnostic Radiation Categories Administered by Hospital Size	22
5.	Rates of Any Diagnostic Radiation and Total Diagnostic Radiation Categories Administered by Age	23
6.	Rates of Any Diagnostic Radiation and Total Diagnostic Radiation Categories Administered by Diagnosis	24
7.	Diagnostic Radiation Categories Administered by Year	25
8.	Rates of Any Diagnostic Radiation and Diagnostic Radiation Categories Administered by Hospital Size, 1963	26
9.	Rates of Any Diagnostic Radiation and Diagnostic Radiation Categories Administered by Age, 1963	27
10.	Rates of Any Diagnostic Radiation and Diagnostic Radiation Categories Administered by Diagnosis, 1963	28

CONTENTS

TABLES

		PAGE
11.	Rates of Any Diagnostic Radiation and Diagnostic Radiation Categories Administered by Hospital Size, 1966	29
12.	Rates of Any Diagnostic Radiation and Diagnostic Radiation Categories Administered by Age, 1966	30
13.	Rates of Any Diagnostic Radiation and Diagnostic Radiation Categories Administered by Diagnosis, 1966	31
14.	Rates of Any Diagnostic Radiation and Diagnostic Radiation Categories Administered by Hospital Size, 1968	32
15.	Rates of Any Diagnostic Radiation and Diagnostic Radiation Categories Administered by Age, 1968	33
16.	Rates of Any Diagnostic Radiation and Diagnostic Radiation Categories Administered by Diagnosis, 1968	34
17.	Observed and Adjusted Rates per 1,000 of Any Diagnostic Radiation Total Data and Selected Data Deleted	35
18.	Annual Increase in Rates of Any Diagnostic Radiation, and Total Diagnostic Categories Administered by Hospital Size	36
19.	Annual Increase in Rates of Any Diagnostic Radiation, and Total Diagnostic Radiation Categories Administered by Age	37
20.	Annual Increase in Rates of Any Diagnostic Radiation, and Total Diagnostic Radiation Categories Administered by Diagnosis	38
21.	Annual Increase in Observed and Adjusted Rates of Any Diagnostic Radiation, and Total Diagnostic Categories Administered, Total Data and After Selected Data Deleted (Percent Increase)	39
22.	Annual Increase in Observed and Adjusted Rates of any Diagnostic Radiation and Total Diagnostic Categories Administered, Total Data and After Selected Data Deleted	40
23.	Age Specific Rates of Any Diagnostic Radiation, Observed and Adjusted for Diagnosis	41
24.	Probability of Discharges Receiving Various Numbers of Ten Categories of Diagnostic Radiation During a Hospital Stay	42
25.	Number of Categories Utilized in Combination, Possible and Observed	43
26.	Combinations and Categories by Grouped Discharges With Diagnostic Radiation	44
27.	Percentage of Diagnostic Radiation Category Combinations, 1963	45
28.	Percentage of Diagnostic Radiation Category Combinations, 1966	46
29.	Percentage of Diagnostic Radiation Category Combinations, 1968	47
30.	Combinations of Radiation Categories Having Greatest Number of Discharges	48
31.	Rates by Diagnostic Radiation Category for Study and Non-Study Hospitals	49

CONTENTS

FIGURES

		PAGE
1.	Rate of Any Diagnostic Radiation by Hospital Size	7
2.	Rate of Any Diagnostic Radiation by Age	8
3.	Age Specific Rates of Any Diagnostic Radiation Observed and Adjusted for Diagnosis	11
4.	Short-term General Hospital by Hospital Size for the U.S. Study and Non-Study Groups	14

DIAGNOSTIC RADIATION UTILIZATION IN SELECTED SHORT-TERM GENERAL HOSPITALS
(United States - 1963, 1966 and 1968)

BACKGROUND AND OBJECTIVES

Several previous reports indicate that the U.S. population receives a substantial proportion of its total radiation exposure from medical radiation (1-5). Little information is available, however, on the trends that patient exposure might assume in the next few years. Such trends are necessary for studies aimed at projecting the extent of future medical radiation exposure of the population. Hemphill and Hesselgren reported on hospital diagnostic radiation trends between 1963 and 1966(6) and Kunz reported on population exposure to diagnostic x rays in Czechoslovakia in 1965-1966(7).

This study explores the trends and patterns of medical radiation by comparing 1963, 1966 and 1968 statistics of ten diagnostic radiation categories (DRC) utilized in a set of non-federal short-term general hospitals (study hospitals). Because relatively few patients receive radiation therapy in short-term general hospitals* therapeutic radiation data were not included in this study.

Data for this study were obtained from 228 community type hospitals in the contiguous United States which participated in the Professional Activity Study (PAS) program of the Commission on Professional and Hospital Activities (CPHA) continuously from 1963 through 1967. By 1968, two of the hospitals had consolidated and one having "less than 50 beds" had ceased participating in PAS. These changes were judged to be inconsequential to the objectives of this study of gross patterns and trends.

---

*Less than four per 1000 among 4 million persons discharged from hospitals participating in the Professional Activity Study program of the Commission on Professional and Hospital Activities, 1968 (Unpublished data).

Data for 1963 were selected to establish base lines for trends and patterns; selection of 1966 data was predicated, in part, on Medicare legislation which became effective July 1, 1966(8); 1968 data were chosen to extend the study of trends.

This report contains data from a study reported by Hemphill and Hesselgren(6) and provides similar information from the same hospitals for the year 1968, extending the scope and breadth of information toward the following objectives:

(1) To examine diagnostic radiation trends in the same short-term general hospitals, specifically to determine (a) the rate (frequency per 1,000 discharges) that each of ten diagnostic radiation categories (DRC) was used (plus no radiation), (b) the rate that "any" of the DRC was used, (c) the rate of "total" DRC administered, and (d) patterns of utilization of combinations of the DRC.

(2) To relate data from (1) to hospital size (number of beds), age of patient, and diagnosis (Appendix A).

SCOPE AND SOURCE OF SUBJECT DATA

Data for this study were purchased by the Bureau of Radiological Health from the Commission on Professional and Hospital Activities (CPHA) of Ann Arbor, Michigan(9). Through contracts with hospitals, CPHA receives an abstract of each discharged patient's hospital record. Each abstract pertains to one hospital stay. At CPHA these abstracts are arranged sequentially on composite six-month tapes by patient number and "final diagnosis* explaining admission" within each hospital. The six-month tapes for 1963, 1966, and 1968 were the source from which the data for this paper were retrieved by systematic sampling. Each six-month's block of data from the study hospitals contained more than 1,000,000 abstracts from patients' records.

Abstracts prepared in the participating hospitals record whether each of the ten DRC identified in PAS was administered during the hospital stay or within two days prior to admission. Absence of notation on all the ten DRC indicated that no diagnostic radiation was administered during the stay. The ten DRC are: (1) Survey chest (minifilm and routine large film), (2) radioactive tracers, (3) external

---

*Coded according to International Classification of Diseases, Adapted (ICDA).

soft tissue, (4) cardiovascular, (5) central nervous system and CNS spaces, (6) pleural and peritoneal cavities, (7) urogenital, (8) digestive tracts, (9) skeletal, (10) chest-respiratory (large film).

Every large set of data routinely collected presents inadequacies. Qualifications of these data include:

(1) Probability bases were not used to select the study hospitals. Therefore, no basis exists for statistical extrapolation of findings to populations of hospitals other than the set (228) studied.

(2) Fluoroscopy is not identified separately in the study data.

(3) The number of repetitions of any DRC during a hospital stay is not recorded in PAS.

(4) The study data do not identify individual hospitals.

(5) The data are inappropriate for quantitative (energy) estimation of exposure or dosage.

(6) Minor (inconsequential) instances of illogical classification appear in the data.

After investigation of the qualifications, the data were accepted for study of gross patterns and trends of diagnostic radiation practices in the set of study hospitals.

METHODS OF STUDY

Methods used in this study are largely conventional. Definitions and concepts adopted for this study follow.

The "rate per 1,000 discharges" was adopted as the general basis for comparison. Because the samples are large, usual statistical methods were used to compute variance(10). Sampling statistics derived from these data are applicable only to the study data, not to data from any other population of hospitals.

Sampling resulted in economical data management. The sampling procedure was systematic; i.e., each "nth" record was selected;

1:25 for 1963, 1968 and January-June 1966; 1:32 for July-December 1966. In studying combinations of DRC, data from January-June of each study year were used in order to have data sampled at the same rate.

Over the years 1963-1968, there were known to be two influences potentially effective in causing shifts in percentage distribution of hospital populations, namely, declining birth rate and implementation of Medicare legislation. Also, there was known to be a large difference in diagnostic radiation utilization between age groups of hospitalized patients, e.g., newborn as compared to those 60 years of age. For these reasons, effects of shifts between 1963, 1966, and 1968 in the percentage distribution of discharges were studied with regard to hospital size, age of patients, and diagnosis separately, and for age-diagnosis jointly.

There are several approaches to assess the quantity of change in utilization rates (Appendix B).

Data on the variables were arbitrarily subgrouped for this report and the attending analyses, as follows: Size of hospital, 7 groups; age of patients, 6 groups; diagnosis, 20 groups (see Appendix A). Mathematical considerations of ideal or optimum segmentation of data exceed the scope of this study.

The following definitions and comments are intended to assist the reader:

(1) Statistically significant means $p < .01$.

(2) rate for "any DRC" = 1000 (number of discharges receiving any of the 10 DRC)/ (total discharges)

(3) rate for "total DRC" = 1000 (number of all DRC administrations) / (total discharges). This rate has two components, namely, (1) the number of discharges receiving "at least one DRC" and (2) the number of DRC administrations accumulating from discharges receiving 2,3,4,.....,10 of the DRC. Instances of 2,3,4,.....,10 of the DRC are referred to as "conjoint" combinations (of the ten DRC); only one DRC as "disjoint".

(4) The distribution composed of data from two or more variables, e.g., "age" and "diagnosis" is a "joint distribution".

FINDINGS

The following results of analyses first generally discuss patient discharge distributions and DRC rates overall and by specific categories. The following sections deal with variables of primary study interest, size of hospital, age of patient, and diagnosis, with further discussions of discharge distributions. Then follows the topic of utilization of more than one of the ten DRC during a hospital stay (conjoint use). The final two sections concern studies of within-year changes, and comparison of study-hospital utilization patterns with those of a set of non-study hospitals, 1966.

Discharge Distributions

There were significant shifts in the percentage distribution of discharges by hospital size, age, and diagnosis (Tables 1-3) from year to year. The age distribution shifted among subgroups of hospital size and diagnosis groups, as indicated by the average age. Since radiation rates vary by subgroupings of age and diagnosis and to a much lesser extent by hospital size, the changes in the discharge distribution affect the overall observed rates. These effects were considered in the quantitative evaluation of changes in trends.

Table 1 shows relatively minor shifts in percentage distribution of discharges by hospital size subgroups. The average age of patients tends to be higher for smaller-size hospitals. Between the study years, there was an increase in average age for each subgroup, with an unusually large increment appearing in the <50 group between 1966 and 1968.

Changes between the years in the percentage distribution of age groups are shown in Table 2, the most marked changes being decrements in births and <15, with increments in 60+. There were highly significant increments in average age between the years.

The distribution of discharges tended to show increases by year in diagnoses associated with increased age such as malignant neoplasms, central nervous system, circulatory, endocrine, blood and bones, Table 3. Conversely there was a decrease or no appreciable change for diagnoses relatable to younger patients, such as congenital malformations, diseases of early infancy, deliveries, respiratory, and infective.

Analyses assessing these effects are discussed below under the topics hospital size, age of patient, and discharge diagnosis.

Overall Rates

Tables 4-6 show an increased proportion of patients received diagnostic radiation (any DRC) during each consecutive study year, and of those receiving such radiation, an increased number of the ten DRC (total DRC) was administered. For 1963, 1966 and 1968 respectively, the rates for any DRC were 463, 513, and 547; for total DRC, 717, 862, and 953. The difference between each of the yearly rates is statistically highly significant. The average annual rate increase for any DRC and total DRC was 17 and 47 respectively (Table 22). The average annual percent increase in rate for total DRC (over 6%) approximated almost twice that for any DRC (over 3%) (Tables 21 and 22).

Diagnostic Radiation Categories

Table 7 shows 1963, 1966, and 1968 rates of utilization of each of the ten DRC. Between 1963 and 1968, eight of the categories showed significant increments with a significant decrement for "survey chest". Only "external soft tissue" showed no change. From study-year to study-year, highly significant increments are shown in rates for "chest respiratory" and for "radioactive tracers." Similarly notable is the year-to-year decrement for "survey chest." With the decreased use of "survey chest," the most frequently used category was "chest respiratory" followed by "skeletal" and "digestive." The least used category was "external soft tissue."

The overall tendency (exceptions exist) for relative change study-year to study-year in these and other of the rates by the individual DRC was toward uniformity by subgroups of the variables, Tables 8-16. This tendency held for the rates of any DRC and total DRC.

Hospital Size

Table 4 and Figure 1 show that each hospital-size group had increased rates of any DRC and total DRC in each study year subsequent to 1963. The highest of these rates each year was in the smallest group (<50 beds) and second highest in the largest groups (400+). The exceedingly large increment in DRC rates between 1966 and 1968 in the <50 subgroup is associated with the increase in average age discussed previously (Table 18).

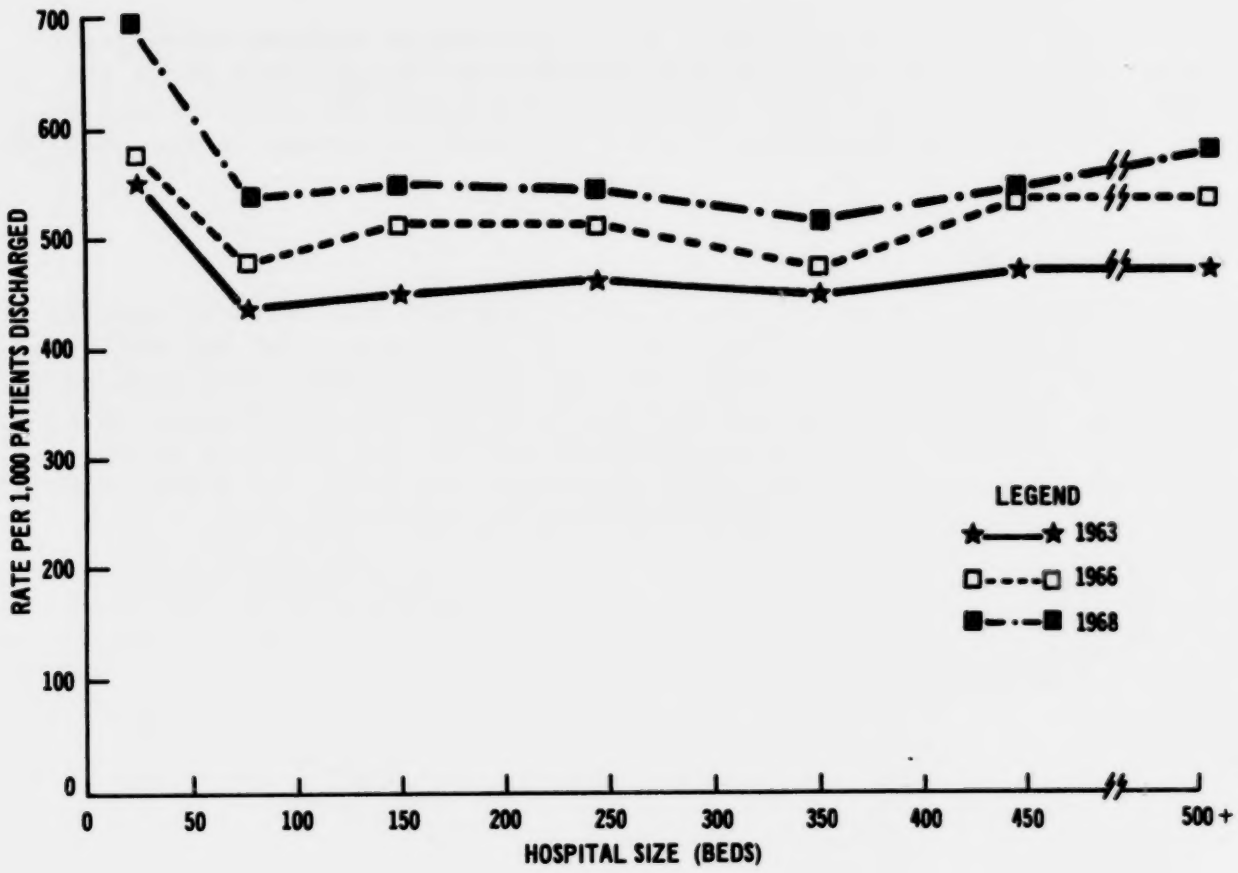

Figure 1. Rate of Any Diagnostic Radiation by Hospital Size. Selected Short-Term General Hospitals, U.S., 1963, 1966, 1968.

Considering the rates for the separate DRC (Tables 8, 11, 14), the trend and pattern of the hospital groups other than the <50 was for regular changes by DRC category. The <50 group shows for 1968 a distinct break by an overwhelming increase in the chest categories, both "survey" and "respiratory"; in 1963, the <50 had the highest rates for "survey chest" and "digestive system " to which by 1968 had been added "urogenital" and "chest respiratory."

Even though the distributions of discharges between study years were statistically different and significant changes were shown in DRC rates by hospital size subgroups, adjustment for differences in the discharge distributions results in almost no change in the observed rates.

Age of Patients

Table 5 and Figure 2 show a wide range for the rates of any DRC and total DRC with the lowest for births and highest for age 60+, e.g., 44 to 811 for any DRC in 1968. Any DRC and total DRC rates increased consistently with age except for the 15-29 age group. Changes in rates of the separate ten DRC were generally similar for each age group (Tables 9, 12, 15). These rates increased for every age group, with the relative increase being highest for births, Table 19.

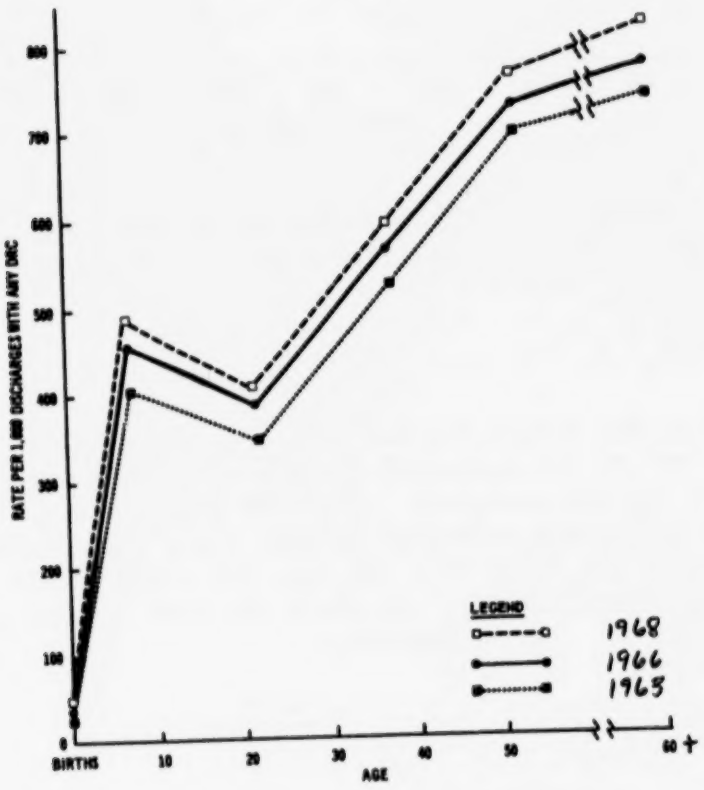

Figure 2. Rate of Any Diagnostic Radiation by Age. Selected Short-Term General Hospitals, U.S., 1963, 1966, 1968.

The age distribution of discharges shifted significantly towards older patients over the study years, (Table 2) consistent with the known declining birth rate and the presumption that Medicare legislation would result in increased hospitalized care for the aged.

Adjusting the overall rates for age distribution differences explains part of the overall increase, but significant increments remain (Table 17). The average annual increase for age adjusted rates was 13 and 38 for any DRC and total DRC, with the average annual percent increase being 2.7 and 5.3 (Tables 21, 22). Analyses were made deleting the diagnosis groups of births and deliveries. The adjustment for age after this deletion had only a small effect on the overall observed rate. This indicates that most of the effect on rates due to difference in age distributions is in these two diagnosis groups.

Diagnosis

Table 6 shows that statistically significant increases in DRC rates between 1963, 1966, and 1968 occurred in seventeen diagnosis groups; the exceptions were congenital malformations and diseases of early infancy, which showed up and down patterns, and deliveries which had small increases (not significant). Relatively, births showed the largest increase in any DRC (10%) with 5-6% increase in skin and nervous system next (Table 20).

Each study year, the lowest rates were in births and deliveries, two groups for which radiation utilization is believed to be hazardous. The highest rate of any DRC each year was for symptoms, a group for which radiation may often assist in determining diagnoses.

The overall increase in rates between 1963 and 1968 for chest respiratory and radioactive tracers, and decrease for survey chest appeared in each diagnosis group (Tables 10,13,16). These three DRC accounted for about half of the total DRC. The remaining seven showed much less relative change between study years and an increased variability of change.

Adjusting the rates for differences in diagnosis distributions explains part of the difference in overall observed rates, Table 17, but significant increments remain. Analyses excluding the data from births and deliveries, etc., demonstrated the disproportionate weight of the excluded data. Subsequent to the exclusion, adjustment of the observed rates produced an inconsequential effect.

Effects of Adjustment of Separate and Joint Variables

From above, both "age" and "diagnosis" are variables important to assessment of the trend of DRC utilization. This section contains evaluations of the combined effects on the any DRC rate of the two variables.

Table 17 shows observed and adjusted rates of the variables studied and for the joint age-diagnosis. The average annual increase in observed rate between 1963 and 1968 approximated 17 per 1000. Adjustment for hospital-size distribution differences explains essentially none of the observed increments; adjustment for age distribution, 1963-1966, explains 26% of the observed annual increase in rate (17 per 1000); diagnosis, 38%; and age-diagnosis, 42% (or conversely, 74%, 62%, and 58% of the rate increase is attributed to increased utilization).

For 1963-1968, the percentages explained are, respectively, 25, 30, and 37, Table 17. Changes in distribution and rates by subgroups of age-diagnosis were not consistent between 1963-1966 and 1966-1968.

The more important points of these analyses are that adjustments for age of patients and diagnosis are important, that the joint effects are greater than that of either alone but less than the sum of the separate effects. Some 40% of the increase in observed rates may be attributed to shifts in the age-diagnosis distribution between the study years, e.g., the observed annual increment of 17 per 1000 is more realistically some 11 per 1000.

Table 17 further provides evidence of the disproportionate effect of shifts in maternity-related ICDA codes for evaluation of changes in the any-DRC rates.

Table 23 and Figure 3 show for each age group the any-DRC rates after adjustment for shifts in diagnosis distribution. The rates show increments for each age group in the any-DRC rates.

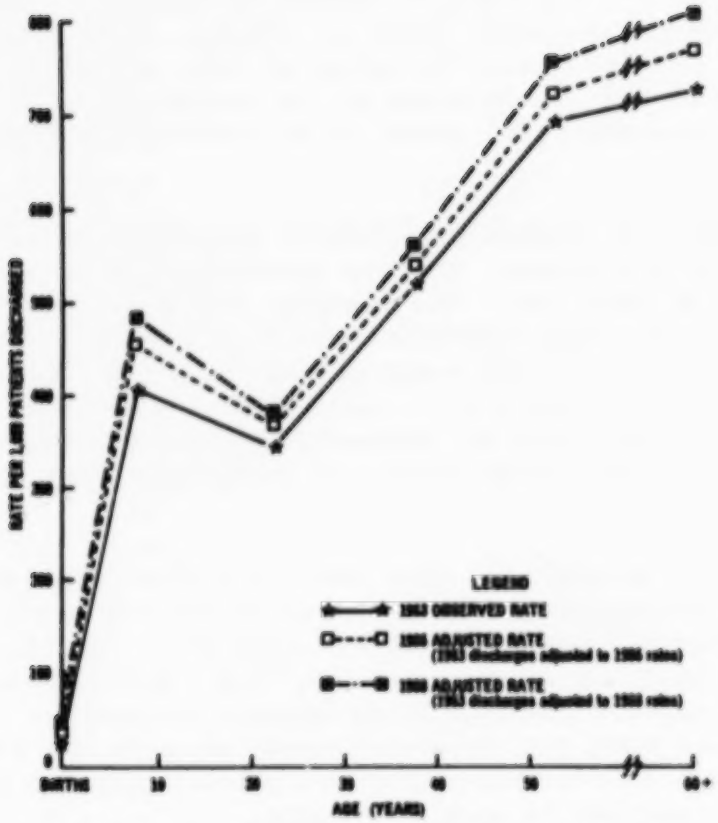

Figure 3. Age Specific Rates of Any Diagnostic Radiation, Observed and Adjusted for Diagnosis. Selected Short-Term General Hospitals, U.S., 1963, 1966, 1968.

Combinations of DRC

This section contains the results of analyses exploring patterns and trends of the utilization of the ten DRC, singly (disjoint) and in multiples (conjoint). The tables show, in different ways, the increasing use of multiple categories from study year to study year.

Table 24 shows the distribution of discharges for each year by number of combined categories administered and various probabilities. The data show an increased probability from year to year of utilization of more conjoint DRCs.

Table 25 shows the theoretical number of possible combinations of the ten DRC (using conventional binomial theory, which considers all possibilities as combinations, including no DRC, one DRC, two DRC, etc.) compared with the observed number of combinations each year. From study year to study year, there is an increased number of DRC per combination.

Table 26 shows the number of specific combinations utilized by grouped numbers of discharges, and the cumulative percent of discharges receiving those combinations. For example, in 1963, each of four different combinations was administered to more than 1,000 discharges; each of 55 combinations to discharge groups of 10-99. Of the 241 different combinations observed, 71 (over 25%) were administered to one patient each. There was an increased number of different combinations of DRC for smaller sized groups of discharges from study year to study year.

Tables 27-29 show for each year the total discharges receiving each DRC and the percentages of these discharges receiving that particular category (1) singly (diagonal entries), and (2) with each other DRC in combinations of at least two (row totals exceed 100% because the discharges receiving three or more categories combined are counted in more than one cell). The use of only one category alone (disjoints), generally declined, with the percentages for conjoints generally showing increments over the years.

Table 30 shows the rank order of the 15 most frequently administered combinations. These 15 accounted for approximately 80% of the discharges with radiation each year, with the highest four accounting for more than 50%. Shifts between years of specific combinations are noticeable, mostly between 1963 and 1966, with the first ten ranks remaining the same between 1966 and 1968, but in different order. "Survey chest" disjoint descended in rank; "skeletal" disjoint and "chest respiratory" disjoint ascended; the conjoint of "skeletal"-"chest respiratory" ascended; "radioactive tracers" in two conjoints ascended to the top 15 ranks first in 1968.

Although the above tables show primarily the increasing use of multiple categories over time, there are other items for analyses. The data are observed and have not been adjusted for differences in discharge distributions by age or diagnosis.

Within-year Variation

Comparison of within-year study data was possible only between the two six-month periods for 1963, 1966, and 1968. Table 31 shows rates for the study hospitals of any DRC, total DRC and for each of the ten DRC for January-June and July-December, 1966. Similar data for 1963 and 1968 were studied but are not shown in this report.

Because the Medicare program became effective July 1, 1966, there was supposition that 1966 within-year changes might exceed those of 1963 and 1968. The data did not support the supposition.

Within-year changes in the DRC rates were small compared to between-year variation.

Comparison of Study Hospitals with Selected (non-study) Hospitals, 1966

The 228 hospitals included in this study are not a probability sample of short-term general hospitals in the United States but are a subset of those hospitals which had a contractual arrangement with CPHA during 1963-1967. In order to test whether the 228 are a truly unique set in regard to radiation utilization, data were accumulated on those short-term general hospitals which were participating in CPHA during 1966 but not in 1963 (non-study hospitals) for comparison with the 228 on distributions by hospital size and radiation data for 1966. Table 31 shows that the study and non-study hospitals had a similar pattern of utilization of the 10 DRC. The distribution by size of non-study hospitals was more like the 228 than that of all U.S. Hospitals, Figure 4.

July-December 1966 data include 741 (228 + 513) of the nation's 5,000 plus non-federal short-term general hospitals(12). Figure 4 shows that the 741 hospitals have a median number of beds much larger than the typical hospital, and therefore, include at least 15% of all discharges from short-term general hospitals in the nation.

Conclusions reached from comparing data between the set of study hospitals and two larger sets of non-study hospitals similar in distribution by hospital size (chi-square, $p > .05$) and having the same criteria for selection, i.e., participation in PAS, follow:

(1) The DRC data from study hospitals were quite similar to those from the non-study hospitals to which they were compared. The study hospitals are not a unique set with regard to DRC utilization patterns.

(2) Diagnostic radiation utilization indices may be similar for sets of short-term general hospitals of like bed-size constituency.

(3) The 741 (study plus non-study) hospitals were not selected on a probability base but did contain a substantial proportion (> 15%) of the nation's discharges from non-federal short-term general hospitals, 1966.

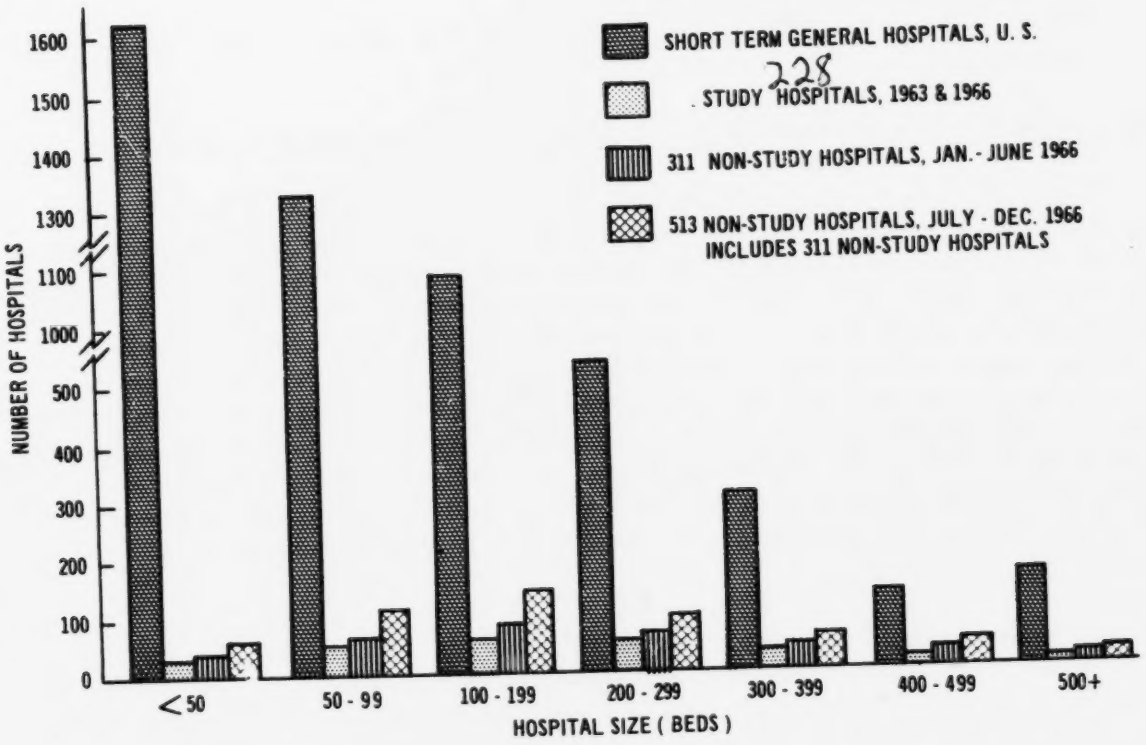

Figure 4. Short-Term General Hospitals by Hospital Size for the U.S. Study and Non-Study Groups.

Unless superior data not now known to exist on trends and patterns of utilization of diagnostic radiation for in-patients become available, findings from this study could serve as baselines from which to project probability selection for classically designed studies.

SUMMARY AND DISCUSSION

The discharge distribution between study years differed significantly by (1) hospital size, (2) age of patient, and (3) diagnosis. Increments in average age of patients between study years and by subgroups of hospital-size and diagnosis were statistically significant and meaningful for interpretation of trends and patterns.

Trends of Utilization

From study-year to study-year, the proportional decrease in discharges for births and deliveries was accompanied by increased rates for any DRC and total DRC which (1) tended toward greater uniformity by hospital-size subgroups than those of either age or diagnosis, and (2) increased significantly between study years; also the annual rate of increase of the total-DRC rate approximated twice that for the any-DRC rate. Between 1966 and 1968 the highly significant and unusual increase in average age of patients in the <50-bed hospitals was accompanied by unusually high rates of separate DRC. These and related findings indicate that meaningful evaluation of changes in the observed overall rates should consider the variation of discharge distributions and rates by subgroups of the variables hospital-size, age-of-patient, and diagnosis. Methods used for these considerations involved quantitative appraisal of changes from the observed overall rates resulting from adjustment of the observed distributions of discharges and rates.

Appraisal by adjustment of hospital-size data showed no change from the observed overall rates. Decrements from both age-of-patient and diagnosis, separately, were highly significant and still larger (but not additive) decrements were shown for the joint effects of age-diagnosis. Age or diagnosis effects were expected to affect overall DRC rates but diagnosis effects were not expected to outweigh age effects. Quantitative assessments of these effects, separately or combined, was unknown prior to this study.

The annual average observed increment in the overall any-DRC rate, 1963-1968, approximated 17 per 1000 discharges. Adjustments for subgroup distribution and rate variation between the study years indicated that a more realistic trend rate would be 11 per 1000 discharges, approximately 1% per year.

The average annual rate increase for total DRC approximated twice that for any DRC. The total DRC rate trend was subject to the influence of discharge population variations in age-of-patient and diagnosis similar to that of any DRC rates and, in addition, was augmented by an increased rate of utilization of three-and-more of the ten DRC per patient hospital stay.

For the study set of hospitals over the study years, the trend was for significant average annual increases in the proportion of in-patients to receive diagnostic radiation and to receive an increased number of the ten DRC per hospital stay.

Patterns of Utilization

Patterns of utilization of the separate ten DRC tended to be the same in each study year, characterized by large between-year increments accruing to chest respiratory and radioactive tracers and a large between-year decrement to survey chest. Each year, more than 50% of the total DRC was accounted for by chest respiratory plus survey chest; most infrequently used were external soft tissue, cardiovascular, and central nervous system.

Magnitude and direction of change between study years for each subgroup of "hospital size," "age of patient," and "diagnosis"tended toward uniformity with notable exceptions, e.g., for hospital size of <50 beds, 1966-1968, there were sharp increases in observed rates of the five most frequently used DRC and a reversal of the pattern of decrease for survey chest. Within-year patterns in the use of the 10 DRC was more consistent for subgroups of variables "age" and "diagnosis" than that of "hospital size".

Utilization of Combinations of DRC

The year-to-year trend of use of combinations of the ten DRC was toward an increased average number of the DRC per patient receiving any DRC; decrease in relative frequency of disjoint DRC; and considerable variability among the 15 specific combinations having most frequent use which accounted for approximately 80% of all patients receiving any DRC.

Of 1023 potential combinations of the ten DRC (i.e., theoretically possible utilizations of one or more specific DRC), approximately 25% was used January-June of each study year of which some 25% was used on only one patient.

Miscellaneous

Within-year (six-month periods) rates and patterns were remarkably similar for each study year. The data for 1966 did not support the pre-study supposition that the beginning of Medicare might show an immediate shift in DRC utilization.

The 1966 data from the set of study hospitals were compared with those from sets of hospitals selected by the same criteria and having statistically similar distributions by hospital size. Findings of likeness in rates and patterns between the sets of data led to the conclusion that the DRC utilization data from the set of study hospitals are not unique and suggested that sets of short-term general hospitals having like bed-size constituency might show similarity in DRC utilization practices.

BLANK PAGE

Preceding page blank

Table 1

Distribution and Average Age of Discharges by Hospital Size
Selected Short-term General Hospitals, U.S. 1963, 1966, 1968

Hospital Size (Beds)	1963		1966		1968	
	Percent Distr.	Average Age	Percent Distr.	Average Age	Percent Distr.	Average Age
< 50	1.6	34.9	1.4	36.6	1.7	41.1
50-99	6.4	33.2	6.3	35.1	6.4	37.3
100-199	16.1	33.5	15.9	34.4	16.2	35.8
200-299	26.8	32.4	27.2	34.2	27.2	35.2
300-399	21.1	31.4	21.1	32.7	20.5	34.0
400-499	14.1	33.0	13.9	34.5	13.9	35.2
500+	13.9	32.8	14.3	34.0	14.1	34.8
TOTAL	100.0	32.6	100.0	34.0	100.0	35.2
Total Discharges[a/]	82,820		75,635		85,572	

a/ Sampling rate: 1:25 January-December 1963, 1968 and January-June 1966
1:32 July-December 1966

Table 2

Percent Distribution of Discharges by Age
Selected Short-term General Hospitals, U.S., 1963, 1966, 1968

Age Group	Percent Distribution		
	1963	1966	1968
Births	13.4	12.0	11.5
< 15	15.0	14.3	13.1
15-29	21.5	22.0	22.5
30-44	17.8	16.5	15.7
45-59	15.0	15.8	15.8
60+	17.2	19.3	21.5
TOTAL	100.0	100.0	100.0
Average age ($\bar{x}$) and S.D. $\bar{x}$	32.6 ± 0.08	34.0 ± 0.08	35.2 ± 0.08
Total Discharges a/	82,820	75,635	85,572

a/ Sampling rate - 1:25 January-December, 1963, 1968 and January-June, 1966
1:32 July-December, 1966

Table 3

Distribution and Average Age of Discharges by Diagnosis
Selected Short-term General Hospitals, U.S., 1963, 1966, 1968

Diagnosis	1963		1966		1968	
	Percent Distr.	Average Age	Percent Distr.	Average Age	Percent Distr.	Average Age
Infective	0.8	28	0.9	28	0.8	32
Mal. Neop.	3.2	58	3.6	58	3.7	59
Ben. Neop.	2.8	41	2.9	40	2.9	42
Endoc. Syst.	2.1	48	2.3	47	2.4	48
Blood, etc.	0.5	44	0.5	45	0.5	46
Mental	1.6	42	1.9	43	1.9	44
Nervous Syst.	4.3	47	4.7	48	6.3	52
Circul. Syst.	7.3	56	7.8	57	7.2	57
Resp. Syst.	10.8	23	10.3	24	9.7	26
Digestive	12.1	42	12.6	43	12.1	43
Urogenital	8.1	42	8.5	43	9.0	43
Delivery, etc.	16.4	27	14.6	26	14.2	26
Skin, etc.	1.2	36	1.0	37	1.0	37
Bones, etc.	3.4	43	3.8	44	4.0	45
Cong. Malf.	0.8	19	0.9	17	0.8	18
Early Inf.	0.2	8	0.1	8	0.1	8
Symptoms, etc.	2.7	38	2.6	39	2.7	40
Injuries, etc.	7.8	36	8.2	36	8.3	37
Special	0.6	35	0.7	36	0.7	39
Births	13.4	-	12.1	-	11.5	-
TOTAL	100.0	32.6	100.0	34.0	100.0	35.2
Total Discharges a/	82,820		75,635		85,572	

a/ Sampling rate: 1:25 January-December 1963, 1968 and January-June, 1966
1:32 July-December 1966

Table 4

Rates of Any Diagnostic Radiation and Total Diagnostic Radiation Categories
Administered by Hospital Size
Selected Short-term General Hospitals, U.S., 1963, 1966, and 1968

Hospital Size (Beds)	1963			1966			1968		
	Number of Discharges	Rate/1000 Disch. Any DRC	Rate/1000 Disch. Total DRC Adm.	Number of Discharges	Rate/1000 Disch. Any DRC	Rate/1000 Disch. Total DRC Adm.	Number of Discharges	Rate/1000 Disch. Any DRC	Rate/1000 Disch. Total DRC Adm.
<50	1,307	549	803	1,070	577	939	1,472	694	1,486
50-99	5,336	433	600	4,737	480	738	5,430	536	833
100-199	13,307	456	657	11,997	517	820	13,831	551	909
200-299	22,180	466	724	20,545	513	860	23,312	545	927
300-399	17,479	456	696	15,980	478	807	17,574	519	884
400-499	11,703	474	764	10,480	538	910	11,862	542	945
500+	11,508	473	801	10,826	542	996	12,091	577	1,151
TOTAL[a/]	82,820	463	717	75,635	513	862	85,572	547	953

a/ Sampling rate = 1:25 for 1963, 1968 and January-June 1966
1:32 for July-December 1966

Table 5

Rates of Any Diagnostic Radiation and Total Diagnostic Radiation Categories
Administered by Age
Selected Short-term General Hospitals, U.S., 1963, 1966, and 1968

Age Group	1963			1966			1968		
	Number of Discharges	Rate/1000 Disch.		Number of Discharges	Rate/1000 Disch.		Number of Discharges	Rate/1000 Disch.	
		Any DRC	Total DRC Adm.		Any DRC	Total DRC Adm.		Any DRC	Total DRC Adm.
Births	11,122	29	33	9,125	36	44	9,882	44	53
<15	12,404	404	511	10,855	460	618	11,171	493	660
15-29	17,840	348	476	16,646	389	575	19,225	401	612
30-44	14,748	523	812	12,467	563	967	13,401	595	1,051
45-59	12,446	697	1,173	11,916	725	1,313	13,483	758	1,435
60+	14,270	732	1,234	14,626	774	1,425	18,410	811	1,546
TOTAL[a/]	82,820	463	717	75,635	513	862	85,572	547	953

a/ Sampling rate = 1:25 for 1963, 1968 and January-June 1966
1:32 for July-December 1966

Table 6

Rates of Any Diagnostic Radiation and Total Diagnostic Radiation Categories
Administered by Diagnosis
Selected Short-Term General Hospitals, U.S., 1963, 1966, 1968

Diagnosis	1963			1966			1968		
	Number of Discharges	Rate/1000 Disch. Any DRC	Rate/1000 Disch. Total DRC Adm.	Number of Discharges	Rate/1000 Disch. Any DRC	Rate/1000 Disch. Total DRC Adm.	Number of Discharges	Rate/1000 Disch. Any DRC	Rate/1000 Disch. Total DRC Adm.
Infective	688	621	946	643	663	1075	685	698	1149
Mal. Neop.	2,633	699	1306	2,706	751	1521	3,170	791	1667
Ben. Neop.	2,351	469	724	2,185	530	842	2,483	559	944
Endoc. Syst.	1,765	698	1190	1,743	760	1412	2,052	777	1523
Blood, etc.	391	673	1325	387	724	1561	449	742	1619
Mental	1,312	581	951	1,431	604	1089	1,654	655	1180
Nervous Syst.	3,590	501	790	3,549	540	976	5,421	629	1129
Circul. Syst.	6,009	656	1045	5,924	722	1235	6,185	786	1424
Resp. Syst.	8,957	489	629	7,792	530	720	8,285	576	797
Digestive	9,995	627	1091	9,528	675	1274	10,318	697	1349
Urogenital	6,681	609	993	6,466	637	1091	7,732	666	1173
Delivery, etc.	13,614	189	204	11,049	192	219	12,185	201	239
Skin, etc.	959	394	554	794	467	723	843	509	835
Bones, etc.	2,791	712	1163	2,867	728	1363	3,432	751	1431
Cong. Malf.	665	618	970	681	639	1010	677	614	1021
Early Inf.	128	406	648	99	313	475	108	472	843
Symptoms, etc.	2,195	736	1320	1,966	768	1513	2,319	811	1630
Injuries, etc.	6,456	730	1011	6,185	753	1118	7,125	768	1221
Special	528	487	663	515	546	850	567	534	877
Births	11,112	29	33	9,125	36	44	9,882	44	53
TOTAL a/	82,820	463	717	75,635	513	862	85,572	547	953

a/ Sampling rate: 1:25 for 1963, 1968 and January-June 1966
1:32 for July-December 1966

Table 7

Diagnostic Radiation Categories Administered, by Year
Selected Short-term General Hospitals, U.S., 1963, 1966, 1968

Radiation Category	1963		1966		1968	
	Number	Rate/1,000 Discharges	Number	Rate/1,000 Discharges	Number	Rate/1,000 Discharges
Survey Chest	14,037	169	7,604	101	7,593	89
Rad. Tracers	828	10	2,154	28	3,521	41
Ext. Soft Tissue	176	2	185	2	223	3
Cardiovascular	721	9	1,021	13	1,209	14
Cent. Nerv. Syst.	927	11	936	12	1,216	14
Pleural and Perit.	2,518	30	2,793	37	3,538	41
Urogenital	5,909	71	6,248	83	7,556	88
Digestive	9,575	116	9,420	125	10,661	125
Skeletal	10,623	128	11,079	146	13,465	157
Chest, Resp.	14,063	170	23,778	314	32,575	381
Total Admin.	59,377	717	65,218	862	81,557	953
Total Discharges*	82,820		75,635		85,572	

* Sampling rate = 1:25 for 1963, 1968 and January-June 1966
1:32 for July-December 1966

Table 8

Rates of Any Diagnostic Radiation and Diagnostic Radiation Categories Administered, by Hospital Size
Selected Short-term General Hospitals, U.S., 1963

Hospital Size (Beds)	Number of Discharges[a]	Rate per 1,000 Discharges												
		Any DRC	Diagnostic Radiation Categories (DRC)											
			Total DRC Administ.	Survey Chest	Radioactive Tracers	External Soft Tissue	Cardio-vascular	Central Nervous System	Pleural & Peritoneal Cavities	Uro-genital	Digestive	Skeletal	Chest Respiratory
<50	1,307	549	803	327	1	0	2	3	27	54	147	106	137
50-99	5,336	433	600	146	3	1	3	7	25	49	108	115	145
100-199	13,307	456	657	151	3	1	3	7	24	64	118	121	164
200-299	22,180	466	724	198	6	1	10	10	30	75	113	130	149
300-399	17,479	456	696	160	13	2	8	11	28	75	113	124	162
400-499	11,703	474	764	144	13	4	11	15	37	74	116	133	216
500+	11,508	473	801	168	22	4	16	17	38	77	121	145	195
TOTAL	82,820	463	717	169	10	2	9	11	30	71	116	128	170

a/ Sampling rate = 1:25

Table 9

Rates of Any Diagnostic Radiation and Diagnostic Radiation Categories Administered, by Age
Selected Short-term General Hospitals, U.S., 1963

Age Group	Number of Discharges[a/]	Rate per 1,000 Discharges												
		Any DRC	Diagnostic Radiation Categories (DRC)											
			Total DRC Administ.	Survey Chest	Radioactive Tracers	External Soft Tissue	Cardio-vascular	Central Nervous System	Pleural & Peritoneal Cavities	Uro-genital	Digestive	Skeletal	Chest Respiratory
Births	11,112	29	33	7	0	*	*	*	2	*	2	7	14
<15	12,404	404	511	120	1	1	5	8	18	40	33	116	169
15-29	17,840	348	476	158	6	1	4	8	18	56	52	97	76
30-44	14,748	523	812	217	13	3	8	18	32	91	139	138	151
45-59	12,446	697	1,173	243	20	4	18	22	49	117	228	199	272
60+	14,270	732	1,234	240	19	3	17	11	61	113	232	199	339
TOTAL	82,820	463	717	169	10	2	9	11	30	71	116	128	170

a/ Sampling rate = 1:25

* Less than 0.5

Table 10

Rates of Any Diagnostic Radiation and Diagnostic Radiation Categories Administered, by Diagnosis
Selected Short-term General Hospitals, U.S., 1963

Diagnosis	Number of Discharges[a/]	Rate per 1,000 Discharges											
		Any DRC	Diagnostic Radiation Categories (DRC)										
			Total Administ.	Survey Chest	Radioactive Tracers	External Soft Tissue	Cardio-vascular	Central Nervous System	Pleural & Peritoneal Cavities	Uro-Genital	Digestive	Skeletal	Chest Respiratory
Infective	688	621	946	235	22	3	6	13	51	54	119	118	326
Mal. Neop.	2,633	699	1,306	250	32	12	16	14	90	154	188	169	381
Ben. Neop.	2,351	469	724	250	11	7	7	11	27	77	102	82	152
Endoc. Syst.	1,765	698	1,190	259	70	4	12	14	28	80	190	181	352
Blood, etc.	391	673	1,325	210	66	3	13	3	61	128	358	143	340
Mental	1,312	581	951	231	23	2	8	19	18	36	146	217	252
Nervous Syst.	3,590	501	790	187	9	2	33	44	10	28	57	227	193
Circul. Syst.	6,009	656	1,045	245	20	1	40	6	32	73	168	108	350
Resp. Syst.	8,957	489	629	201	3	1	4	2	9	14	46	49	301
Digestive	9,995	627	1,091	214	14	1	4	2	91	78	427	52	208
Urogenital	6,681	609	993	235	11	5	5	2	55	343	113	54	169
Delivery, etc.	13,614	189	204	136	1	*	*	*	7	32	6	5	17
Skin, etc.	959	394	554	150	2	4	9	0	17	22	64	140	146
Bones, etc.	2,791	712	1,163	208	10	3	6	114	13	47	91	512	158
Cong. Malf.	665	618	970	176	11	8	74	39	48	129	104	153	229
Early Inf.	128	406	648	156	0	0	0	16	47	31	102	86	211
Symptoms, etc.	2,195	736	1,320	205	20	1	22	34	58	192	285	231	272
Injuries, etc.	6,456	730	1,011	129	5	3	3	20	25	27	41	619	137
Special	528	487	663	110	8	0	9	6	15	59	110	235	112
Births	11,112	29	33	7	0	*	*	*	2	*	2	7	14
TOTAL	82,820	463	717	169	10	2	9	11	30	71	116	128	170

a/ Sampling rate = 1:25
* Less than 0.5

Table 11

Rates of Any Diagnostic Radiation and Diagnostic Radiation Categories Administered, by Hospital Size
Selected Short-term General Hospitals, U.S., 1966

Hospital Size (Beds)	Number of Discharges[a/]	Rate per 1,000 Discharges												
		Any DRC	Diagnostic Radiation Categories (DRC)											
			Total DRC Administ.	Survey Chest	Radioactive Tracers	External Soft Tissue	Cardio-vascular	Central Nervous System	Pleural & Peritoneal Cavities	Uro-genital	Digestive	Skeletal	Chest Respiratory
<50	1,070	577	939	275	10	4	0	4	21	42	150	112	322
50-99	4,737	480	738	96	8	2	3	5	26	55	127	126	290
100-199	11,997	517	820	103	16	3	6	7	27	75	123	147	314
200-299	20,545	513	860	100	24	2	19	11	37	91	126	140	309
300-399	15,980	478	807	68	31	2	10	15	36	80	120	151	293
400-499	10,480	538	910	96	30	3	14	20	40	85	125	150	349
500+	10,826	542	996	136	56	3	23	14	52	93	125	161	334
TOTAL	75,635	513	862	101	28	2	13	12	37	83	125	146	314

a/ Sampling rate = 1:25 for January-June; 1:32 for July-December

Table 12

Rates of Any Diagnostic Radiation and Diagnostic Radiation Categories Administered, by Age
Selected Short-term General Hospitals, U.S., 1966

Age Group	Number of Discharges[a/]	Rate per 1,000 Discharges												
		Any DRC	Diagnostic Radiation Categories (DRC)											
			Total DRC Administ.	Survey Chest	Radioactive Tracers	External Soft Tissue	Cardio-vascular	Central Nervous System	Pleural & Peritoneal Cavities	Uro-genital	Digestive	Skeletal	Chest Respiratory
Births	9,125	36	44	3	0	0	*	0	3	1	2	8	27
<15	10,855	460	618	63	6	1	10	6	22	53	37	131	289
15-29	16,646	389	575	111	14	1	6	9	25	59	56	121	173
30-44	12,467	563	967	137	37	4	13	21	37	100	150	159	309
45-59	11,916	725	1,313	137	54	5	24	25	54	126	225	212	451
60+	14,626	774	1,425	117	52	3	24	12	69	132	241	208	566
TOTAL	75,635	513	862	101	28	2	13	12	37	83	125	146	314

a/ Sampling rate = 1:25 for January-June; 1:32 for July-December

* Less than 0.5

Table 13

Rates of Any Diagnostic Radiation and Diagnostic Radiation Categories Administered, by Diagnosis
Selected Short-term General Hospitals, U.S., 1966

Diagnosis	Number of Discharges	Rate per 1,000 Discharges												
		Any DRC	Diagnostic Radiation Categories (DRC)											
			Total Administ.	Survey Chest	Radioactive Tracers	External Soft Tissue	Cardio-vascular	Central Nervous System	Pleural & Peritoneal Cavities	Uro-Genital	Digestive	Skeletal	Chest Respiratory
Infective	643	663	1,075	81	26	0	9	0	67	64	152	118	557
Mal. Neop.	2,706	751	1,521	135	83	12	20	16	92	174	205	204	580
Ben. Neop.	2,185	530	842	168	29	7	15	9	27	86	96	91	313
Endoc. Syst.	1,743	760	1,412	121	124	6	21	6	35	93	216	194	596
Blood, etc.	387	724	1,561	98	140	0	26	5	70	152	370	171	530
Mental	1,431	604	1,089	125	73	1	8	30	15	51	142	238	404
Nervous Syst.	3,549	540	976	103	64	1	54	48	11	36	54	259	347
Circul. Syst.	5,924	722	1,235	110	57	2	56	9	38	85	176	116	586
Resp. Syst.	7,792	530	720	90	11	1	5	1	11	24	47	57	473
Digestive	9,528	675	1,274	130	33	2	5	2	115	93	431	59	405
Urogenital	6,466	637	1,091	146	21	7	7	2	56	358	113	53	328
Delivery, etc.	11,049	192	219	106	2	*	1	*	8	24	5	16	57
Skin, etc.	794	467	723	112	15	4	6	1	13	34	63	181	293
Bones, etc.	2,867	728	1,363	146	33	1	8	130	17	68	108	522	329
Cong. Malf.	681	639	1,010	122	21	1	82	22	26	142	106	181	307
Early Inf.	99	313	475	30	10	0	10	10	20	91	51	51	202
Symptoms, etc.	1,966	768	1,513	110	68	3	32	43	73	202	281	264	436
Injuries, etc.	6,185	753	1,118	71	15	4	8	12	30	31	43	627	278
Special	515	546	850	107	21	0	17	2	19	80	120	247	237
Births	9,125	36	44	3	0	0	*	0	3	1	2	8	27
TOTAL	75,635	513	862	101	28	2	13	12	37	83	125	146	314

a/ Sampling rate = 1:25 for January-June; 1:32 for July-December

* Less than 0.5

Table 14

Rates of Any Diagnostic Radiation and Diagnostic Radiation Categories Administered, by Hospital Size
Selected Short-term General Hospitals, U.S., 1968

Hospital Size (Beds)	Number of Discharges[a/]	Rate per 1,000 Discharges. Diagnostic Radiation Categories (DRC): Any DRC	Total DRC Administ.	Survey Chest	Radioactive Tracers	External Soft Tissue	Cardio-vascular	Central Nervous System	Pleural & Peritoneal Cavities	Uro-genital	Digestive	Skeletal	Chest Respiratory
<50	1,472	694	1,486	431	21	1	4	11	20	109	187	170	533
50-99	5,430	536	833	81	18	1	5	6	41	61	131	135	354
100-199	13,831	551	909	87	23	3	9	11	35	83	133	154	371
200-299	23,312	545	927	88	36	2	13	13	40	94	123	153	365
300-399	17,574	519	884	53	42	2	13	13	41	87	119	154	362
400-499	11,862	542	945	66	51	3	14	19	42	80	123	158	388
500+	12,091	577	1,151	127	74	5	29	21	54	104	118	183	437
TOTAL	85,572	547	953	89	41	3	14	14	41	88	125	157	381

a/ Sampling rate = 1:25

Table 15

Rates of Any Diagnostic Radiation and Diagnostic Radiation Categories Administered, by Age
Selected Short-term General Hospitals, U.S., 1968

Age Group	Number of Discharges[a/]	Rate per 1,000 Discharges												
		Any DRC	Diagnostic Radiation Categories (DRC)											
			Total DRC Administ.	Survey Chest	Radioactive Tracers	External Soft Tissue	Cardio-vascular	Central Nervous System	Pleural & Peritoneal Cavities	Uro-genital	Digestive	Skeletal	Chest Respiratory
Births	9,882	44	53	3	*	0	*	*	3	1	3	10	23
<15	11,171	493	660	48	7	1	6	7	27	56	35	141	331
15-29	19,225	401	612	96	20	1	5	8	29	59	53	125	215
30-44	13,401	595	1,051	120	48	4	12	27	45	107	140	170	378
45-59	13,483	758	1,435	121	76	6	30	27	55	136	220	216	549
60+	18,410	811	1,546	105	76	3	25	13	71	137	238	228	649
TOTAL	85,572	547	953	89	41	3	14	14	41	88	125	157	381

a/ Sampling rate = 1:25

* Less than 0.5

Table 16

Rates of Any Diagnostic Radiation and Diagnostic Radiation Categories Administered, by Diagnosis
Selected Short-term General Hospitals, U.S., 1968

Diagnosis	Number of Discharges	Rate per 1,000 Discharges											
		Any DRC	Diagnostic Radiation Categories (DRC)										
			Total Administ.	Survey Chest	Radioactive Tracers	External Soft Tissue	Cardio-vascular	Central Nervous System	Pleural & Peritoneal Cavities	Uro-Genital	Digestive	Skeletal	Chest Respiratory
Infective	685	698	1,149	76	45	3	10	16	55	88	121	137	597
Mal. Neop.	3,170	791	1,667	102	123	14	19	18	96	189	218	221	667
Ben. Neop.	2,483	559	944	147	41	6	15	10	33	102	112	86	392
Endoc. Syst.	2,052	777	1,523	106	145	4	16	14	42	100	210	231	655
Blood, etc.	449	742	1,619	105	140	4	18	2	87	125	381	158	599
Mental	1,654	655	1,180	93	91	4	10	22	23	52	141	221	522
Nervous Syst.	5,421	629	1,129	92	96	1	48	43	20	37	70	222	501
Circul. Syst.	6,185	786	1,424	110	93	3	73	8	46	100	199	132	660
Resp. Syst.	8,285	576	797	81	18	1	4	2	19	25	56	60	530
Digestive	10,318	697	1,349	115	38	2	4	2	117	97	427	63	484
Urogenital	7,732	666	1,173	131	26	6	6	2	60	368	100	54	420
Delivery, etc.	12,185	201	239	88	4	*	*	*	12	20	5	29	80
Skin, etc.	843	509	835	103	28	4	5	1	21	49	81	190	353
Bones, etc.	3,432	751	1,431	126	37	1	6	147	12	61	96	540	404
Cong. Malf.	677	614	1,021	72	34	1	74	27	34	137	83	196	362
Early Inf.	108	472	843	74	9	0	46	19	28	37	111	130	389
Symptoms, etc.	2,319	811	1,630	86	106	2	28	38	68	219	262	288	534
Injuries, etc.	7,125	768	1,221	66	22	4	8	14	40	36	42	638	351
Special	567	534	877	67	42	2	23	11	16	104	95	228	289
Births	9,882	44	53	3	*	0	*	*	3	1	3	10	33
TOTAL	85,572	547	953	89	41	3	14	14	41	88	125	157	381

a/ Sampling rate = 1:25

* Less than 0.5

Table 17

Observed and Adjusted Rates per 1,000 of Any Diagnostic Radiation
Total Data and Selected Data Deleted
Selected Short-Term General Hospitals, U.S., 1963, 1966, 1968

	Year			% of Obs. Rate Diff.* Due to Increased Utilization	
	1963	1966	1968	1963-1966	1963-1968
TOTAL DATA					
Observed Rate(A_1)	463	513	547		
Adjusted Rates		(B_1) (C_1)	(B_1) (C_1)		
Hospital Size		464 513	464 546	100	99
Age of Patient		476 500	483 526	74	75
Diagnosis		481 494	485 522	62	70
Age-Diagnosis		483 492	491 516	58	63
SELECTED DATA DELETED**					
Observed Rate(A_1)	611	655	691		
Adjusted Rates		(B_1) (C_1)	(B_1) (C_1)		
Hospital Size		611 654	611 691	98	100
Age of Patient		616 650	623 680	89	86
Diagnosis		614 653	613 689	95	97
Age-Diagnosis		617 649	621 681	86	88

B_1 = Adjusted rate using 1963 subgroup rates with subgroup discharges of "i"th year.

C_1 = Adjusted rate using 1963 subgroup discharges with subgroup rates of "i"th year.

* $(A_1 - B_1)/(A_1 - A_{63})$

** ICDA codes (640-689) and (Y20-Y39) deleted (see Appendix A).

Table 18

Annual Increase in Rates of Any Diagnostic Radiation, and Total Diagnostic Categories Administered, by Hospital Size, Selected Short-term General Hospitals, U.S., 1963, 1966, and 1968

Hospital Size (Beds)	Percent Increase per Year					
	In Rate of Any DRC			In Rate of Total DRC		
	1963-1966	1966-1968	1963-1968	1963-1966	1966-1968	1963-1968
< 50	1.7	10.1	5.3	5.6	29.1	17.0
50-99	3.6	5.8	4.8	7.7	6.4	7.8
100-199	4.5	3.3	4.2	8.3	5.2	7.7
200-299	3.7	3.1	3.4	6.3	3.9	5.6
300-399	1.6	4.3	2.8	5.3	4.8	5.4
400-499	4.5	0.4	2.9	6.4	1.9	4.7
500+	4.9	3.2	4.4	8.1	7.8	8.7
TOTAL	3.9	3.3	3.6	6.7	5.3	6.6

Table 19

Annual Increase in Rates of Any Diagnostic Radiation, and Total Diagnostic Radiation Categories Administered, by Age, Selected Short-term General Hospitals, U.S., 1963, 1966, and 1968

Age Group	Percent Increase per Year					
	In Rate of Any DRC			In Rate of Total DRC		
	1963-1966	1966-1968	1963-1968	1963-1966	1966-1968	1963-1968
Births	8.0	11.1	10.3	9.8	10.2	11.2
< 15	4.6	3.3	4.3	7.0	3.3	5.7
15-29	3.8	1.2	2.8	7.3	3.2	5.9
30-44	2.5	2.3	2.5	6.5	4.3	5.9
45-59	1.3	1.7	1.5	4.0	4.9	4.6
60+	2.0	1.9	2.0	5.2	4.1	5.1
TOTAL	3.6	3.3	3.6	6.7	5.3	6.6

Table 20

Annual Increase in Rates of Any Diagnostic Radiation and Total Diagnostic Radiation Categories Administered, by Diagnosis Selected Short-Term General Hospitals, U.S., 1963, 1966, and 1968

Diagnosis	Percent Increase per Year					
	In Rate of Any DRC			In Rate of Total DRC		
	1963-1966	1966-1968	1963-1968	1963-1966	1966-1968	1963-1968
Infective	2.3	2.7	2.5	4.5	3.5	4.3
Mal. Neop.	2.5	2.7	2.6	5.5	4.8	5.5
Ben. Neop.	4.3	2.8	3.8	5.4	6.1	6.1
Endoc. Syst.	3.0	1.1	2.3	6.2	4.0	5.6
Blood, etc.	2.5	1.3	2.1	5.9	1.9	4.4
Mental	1.3	4.2	2.5	4.8	4.2	4.8
Nervous Syst.	2.6	8.3	5.1	7.8	7.9	8.5
Circul. Syst.	3.4	4.5	4.0	6.1	7.7	7.3
Resp. Syst.	2.8	4.4	3.6	4.8	5.4	5.3
Digestive	2.6	1.7	2.2	5.6	3.0	4.7
Urogenital	1.5	2.3	1.9	3.3	3.8	3.6
Delivery, etc.	0.5	2.4	1.3	2.5	4.6	3.4
Skin, etc.	6.2	4.5	5.8	10.2	7.8	10.1
Bones, etc.	0.7	1.6	1.1	5.7	2.5	4.6
Cong. Malf.	1.1	-2.0	-0.1	1.4	.6	1.1
Early Inf.	-7.6	25.4	3.3	8.9	38.8	6.0
Symptoms, etc.	1.4	2.8	2.0	4.9	3.9	4.7
Injuries, etc.	1.1	1.0	1.0	3.6	4.7	4.2
Special	4.0	-1.1	1.9	9.4	1.6	6.5
Births	8.0	11.1	10.3	11.1	10.3	12.1
TOTAL	3.6	3.3	3.6	6.7	5.3	6.6

Table 21

Annual Increase in Observed and Adjusted Rates of Any Diagnostic Radiation, and Total Diagnostic Categories Administered, Total Data and after Selected Data Deleted Selected Short-Term General Hospitals, U.S., 1963, 1966, and 1968

	Percent Increase per Year					
	In Rate of Any DRC			In Rate of Total DRC		
	1963-1966	1966-1968	1963-1968	1963-1966	1966-1968	1963-1968
TOTAL DATA						
Observed Rate	3.6	3.3	3.6	6.7	5.3	6.6
Adjusted Rates						
Hospital Size	3.6	3.2	3.6	6.7	5.2	6.5
Age	2.7	2.6	2.7	5.6	4.2	5.3
Diagnosis	2.2	2.8	2.5	5.0	4.7	5.2
Age-Diagnosis	2.1	2.4	2.3	4.8	4.1	4.8
SELECTED DATA DELETED*						
Observed Rate	2.4	2.7	2.6	5.4	4.7	5.4
Adjusted Rates						
Hospital Size	2.3	2.8	2.6	5.3	4.6	5.3
Age	2.1	2.3	2.3	5.0	3.8	4.8
Diagnosis	2.3	2.8	2.6	5.1	4.6	5.2
Age-Diagnosis	2.1	2.5	2.3	4.9	4.0	4.8

* ICDA Codes (640-689) and (Y20-Y39) deleted (see Appendix A).

Table 22

Annual Increase in Observed and Adjusted Rates of Any Diagnostic Radiation and Total Diagnostic Categories Admintered, Total Data and after Selected Data Deleted Selected Short-Term General Hospitals, U.S., 1963 and 1968

	Rate per 1,000 Discharges			
	Annual Rate Increase		Annual Percent Rate Increase	
	Any DRC	Total DRC	Any DRC	Total DRC
TOTAL DATA				
Observed Rate	17	47	3.6	6.1
Adjusted Rates				
Hospital Size	17	47	3.6	6.5
Age of Patient	13	38	2.7	5.3
Diagnosis Group	12	37	2.5	5.2
Age - Diagnosis	11	34	2.3	4.8
SELECTED DATA DELETED*				
Observed Rate	16	52	2.6	5.4
Adjusted Rates				
Hospital Size	16	52	2.6	5.3
Age of Patient	14	46	2.3	4.8
Diagnosis Group	16	50	2.6	5.2
Age - Diagnosis	14	47	2.3	4.8

* ICDA codes (640-689) and (Y20-Y39) deleted (see Appendix A).

Table 23

Age Specific Rates of Any Diagnostic Radiation,
Observed and Adjusted for Diagnosis
Selected Short-term General Hospitals, U.S., 1963, 1966, 1968

Age Group	Rate per 1,000 Discharges				
	1963	1966		1968	
	Observed	Observed	Adjusted*	Observed	Adjusted*
Births	29	36	36	44	44
< 15	404	460	455	493	485
15-29	348	389	370	401	380
30-44	523	563	542	595	565
45-59	697	725	727	758	764
60+	732	774	774	811	818
TOTAL	463	513	494	547	522

* Adjusted to the 1963 diagnosis distribution for each age group.

Table 24

Probability of Discharges Receiving Various Numbers of Ten Categories of Diagnostic Radiation during a Hospital Stay
Selected Short-term General Hospitals, U.S., January-June, 1963, 1966, 1968

No. of Cat. in Comb. "X"	Number of Discharges			Probability of a Discharge Receiving at Least "X" Categories			Probability of a Discharge Receiving Exactly "X" Categories			Probability of a Disch. Who Received at Least "X" Categories Receiving at Least "X+1" Categories			Probability of a Disch. Who Received at Least "X" Categories Receiving Exactly "X+1" Categories		
	1963	1966	1968	1963	1966	1968	1963	1966	1968	1963	1966	1968	1963	1966	1968
0	22,157	20,742	19,344	1.0000	1.0000	1.0000	.5331	.4870	.4535	.467	.513	.547	.285	.283	.283
1	11,841	12,052	12,077	.4669	.5130	.5465	.2849	.2830	.2832	.390	.448	.482	.272	.284	.297
2	5,288	6,216	6,913	.1819	.2300	.2633	.1272	.1459	.1621	.301	.365	.384	.229	.257	.262
3	1,731	2,520	2,939	.0547	.0841	.1012	.0417	.0592	.0689	.238	.296	.319	.192	.229	.245
4	435	825	1,059	.0130	.0249	.0323	.0105	.0194	.0248	.197	.222	.232	.169	.181	.191
5	90	191	263	.0026	.0055	.0075	.0022	.0045	.0062	.159	.187	.178	.132	.161	.153
6	14	38	49	.0004	.0010	.0013	.0003	.0009	.0011						
7+	3	6	8												
TOTAL	41,559	42,590	42,652												

Table 25

Number of Categories Utilized in Combination, Possible and Observed
Selected Short-Term General Hospitals U.S., 1963, 1966, 1968

No. of Categories Combined	Possible No. of Combinations $(.5 + .5)^{10}$	Observed Combinations January-June 1963 Number	1963 Cum. %	1966 Number	1966 Cum. %	1968 Number	1968 Cum. %
0	1	1	100.0	1	100.0	1	100.0
1	10	10	99.6	10	99.6	10	99.7
2	45	38	95.4	39	96.0	38	96.2
3	120	67	79.7	74	81.9	79	83.1
4	210	77	52.1	76	55.1	82	55.9
5	252	36	20.2	52	27.5	53	27.6
6	210	10	5.4	20	8.7	19	9.3
7	120	3	1.2	3	1.4	7	2.8
8	45	0	0.0	0	*	0	*
9	10	0	0.0	1	*	1	*
10	1	0	0.0	0	0.0	0	0.0
TOTAL	1024	242		276		290	

* Less than .05

Table 26

Combinations and Categories by Grouped Discharges with Diagnostic Radiation
Selected Short-term General Hospitals U.S., 1963, 1966, 1968

Number of Discharges (Groups)	January-June 1963			January-June 1966			January-June 1968		
	Cum. % of Disch.	No. of Diff. Comb. Utilized	Number Categories/ Combination	Cum. % of Disch.	No. of Diff. Comb. Utilized	Number Categories/ Combination	Cum. % of Disch.	No. of Diff. Comb. Utilized	Number Categories/ Combination
1000+	54.7	4	1.0	57.3	5	1.2	56.6	5	1.4
500-999	74.9	5	1.8	71.9	4	1.5	70.4	4	1.5
100-499	88.0	13	2.2	88.7	21	2.4	87.4	20	2.6
10-99	97.8	55	2.7	97.3	61	3.0	97.6	67	3.2
2-9	99.6	93	3.6	99.5	111	3.7	99.7	118	3.9
1	100.0	71	4.3	100.0	73	4.0	100.0	75	4.7
TOTAL	19,402	241	3.4	21,848	275	3.4	23,308	289	3.8

Table 27

Percentage of Diagnostic Radiation Category Combinations
Selected Short-term General Hospitals, U.S.

January-June, 1963

Diagnostic Radiation Category (DRC)	Total Discharges[a]	Diagnostic Radiation Category (DRC)									
		Survey Chest	Radioactive Tracers	External Soft Tissue	Cardio-vascular	Central Nervous System	Pleural and Peritoneal Cavities	Uro-genital	Digestive	Skeletal	Chest Respiratory
Survey Chest	7,206	55	2	*	1	2	5	10	20	16	8
Radioactive Tracers	402	37	7	1	4	3	9	25	47	28	49
External Soft Tissue	95	26	6	18	5	1	7	15	19	26	49
Cardiovascular	323	20	5	1	12	7	10	16	17	29	59
Central Nervous System	471	26	2	*	4	27	4	6	11	48	25
Pleural & Peritoneal	1,187	28	3	1	3	2	17	25	40	16	40
Urogenital	2,936	24	3	*	2	1	10	28	34	16	33
Digestive	4,913	30	4	*	1	1	10	21	25	15	37
Skeletal	5,200	22	2	*	2	4	4	9	14	43	28
Chest, Respiratory	7,172	8	3	1	3	2	7	13	25	20	44

a/ Sampling rate = 1.25

* Less than 0.5

Table 28

Percentage of Diagnostic Radiation Category Combinations
Selected Short-term General Hospitals, U.S.

January-June, 1966

Diagnostic Radiation Category (DRC)	Total Discharges[a]	Diagnostic Radiation Category (DRC)									
		Survey Chest	Radioactive Tracers	External Soft Tissue	Cardio-vascular	Central Nervous System	Pleural and Peritoneal Cavities	Uro-genital	Digestive	Skeletal	Chest Respiratory
Survey Chest	4,395	43	4	*	1	2	5	11	16	16	36
Radioactive Tracers	1,200	13	6	*	9	7	9	23	38	41	72
External Soft Tissue	105	13	10	13	3	0	6	6	20	29	71
Cardiovascular	578	8	18	*	19	11	9	12	14	36	65
Central Nervous System	540	15	15	0	11	20	4	10	12	59	48
Pleural & Peritoneal	1,514	15	7	*	3	1	14	27	44	15	61
Urogenital	3,470	14	8	*	2	2	12	23	37	19	54
Digestive	5,263	14	9	*	2	1	13	24	19	18	63
Skeletal	6,096	12	8	*	3	5	4	11	16	37	47
Chest, Respiratory	13,418	12	6	*	3	2	7	14	25	22	42

a/ Sampling rate = 1:25

* Less than 0.5

Table 29

Percentage of Diagnostic Radiation Category Combinations
Selected Short-term General Hospitals, U.S.

January-June, 1968

Diagnostic Radiation Category (DRC)	Total Discharges[a]	Diagnostic Radiation Category (DRC)									
		Survey Chest	Radioactive Tracers	External Soft Tissue	Cardio-vascular	Central Nervous System	Pleural and Peritoneal Cavities	Uro-genital	Digestive	Skeletal	Chest Respiratory
Survey Chest	3,881	34	5	*	1	2	5	13	17	18	49
Radioactive Tracers	1,727	12	6	1	9	8	8	22	36	44	80
External Soft Tissue	119	15	8	17	3	3	7	17	32	30	68
Cardiovascular	627	9	25	1	15	11	6	17	17	36	68
Central Nervous System	611	12	24	*	12	14	3	10	11	63	58
Pleural & Peritoneal	1,681	11	9	*	2	1	13	27	39	17	69
Urogenital	3,821	13	10	1	3	2	12	19	38	19	64
Digestive	5,409	12	12	1	2	1	12	27	15	20	70
Skeletal	6,603	11	12	1	3	6	4	11	16	33	55
Chest, Respiratory	16,144	12	9	1	3	2	7	15	23	22	41

a/ Sampling rate = 1:25

* Less than 0.5

Table 30

Combinations of Radiation Categories Having Greatest Number of Discharges
Selected Short-Term General Hospitals U.S., 1963, 1966, 1968

Rank	January-June 1963								January-June 1966								January-June 1968							
	Survey Chest	Rad. Tracers	Pl. and Perit.	Urogenital	Digestive	Skeletal	Chest Resp.	Cum. % Disch.	Survey Chest	Rad. Tracers	Pl. and Perit.	Urogenital	Digestive	Skeletal	Chest Resp.	Cum. % Disch.	Survey Chest	Rad. Tracers	Pl. and Perit.	Urogenital	Digestive	Skeletal	Chest Resp.	Cum. % Disch.
1	x							20							x	26							x	28
2							x	37						x		36						x		38
3						x		48	x							45						x	x	45
4					x			55						x	x	51					x		x	51
5					x		x	59					x		x	57	x							57
6				x				63					x			62	x						x	61
7						x	x	68	x						x	66					x			64
8	x				x			71				x				69				x			x	67
9	x					x		75				x			x	72				x				70
10				x			x	77				x	x		x	74				x	x		x	73
11	x			x				78					x	x	x	75			x				x	74
12	x						x	80	x					x		76					x	x	x	75
13				x	x		x	81			x				x	77		x					x	76
14				x	x			82			x					78		x				x	x	77
15		x						83				x	x			79			x					78
Other								17								21								22
TOTAL Discharges with Radiation								Percent 100 Number 19,402								100 21,848								100 23,308

* Three categories (Central Nervous System, Cardio-vascular, and External Soft Tissue) did not appear in the highest 15 ranks in any of the three years.

Table 31

Rates by Diagnostic Radiation Category for Study and Non-study Hospitals
Short-term General Hospitals, U.S., 1966

Hospital Groups and Dates	Number Discharges**	Rate* of Any Radiation	Rates* by Diagnostic Radiation Category (DRC)										
			Rate of Total Radiation Categories Administered	Survey Chest	Radioactive Tracers	External Soft Tissue	Cardio-vascular	Central Nervous System	Pleural & Peritoneal Cavities	Uro-genital	Digestive	Skeletal	Chest Respiratory
228 Study Hospitals, 1966													
Jan.-June	42,590	513	859	103	28	2	14	13	36	81	124	143	315
July-Dec.	33,045	512	867	97	29	2	13	12	39	84	126	151	314
311 Non-study Hospitals, 1966													
Jan.-June	43,553	510	891	150	30	3	15	15	36	80	129	144	289
513 Non-study*** Hospitals, 1966													
July-Dec.	54,471	504	863	122	33	3	12	14	36	79	125	151	288

* Per 1,000 discharges
** Jan.-June, 1966 sampled at 1:25; July-Dec., 1966 sampled at 1:32
*** Includes the 311 hospitals

REFERENCES

1. Brown, M.L., Roney, P.L., and Hilberg, A.W., Estimates of Gonad and Genetically Significant Dose to the United States Population from Diagnostic Roentgenology, Am. J. Public Health, 58:2267-2274, December 1968.

2. Gitlin, J.N. and Lawrence, P.S., Population Exposure to X-rays in U.S., 1964, publication 1519, U.S. Public Health Service, 1966.

3. ICRP/ICRU, Exposure of Man to Ionizing Radiation Arising from Medical Procedures, Physics in Med. and Biol., 107-156, Oct. 1957.

4. Penfil, R.L. and Brown, M.L., Genetically Significant Dose to the United States Population from Diagnostic Medical Roentgenology, 1964, Radiology 90:209-216, February 1968.

5. Williams, K.D. and Sutton, J.S., Survey of the Use of Radionuclides in Medicine: Preliminary Report, publication MORP 68-10, U. S. Department of Health, Education, and Welfare, National Center for Radiological Health, 1968.

6. Hemphill, F.M. and Hesselgren, R.D., Diagnostic Radiation Utilization In 228 Short-Term General Hospitals, U.S. 1963-1966 (submitted to Radiology).

7. Kunz, E., Exposure of the Population of the CSSR to Ionizing Radiation in X-Ray Diagnostics - United Nation Papers.

8. Hess, Arthur E., Medicare: Its Meaning for Public Health, Am. J. Public Health, Vol. 56, No. 1, 10-18, January 1966.

9. Commission on Professional and Hospital Activities, 1968 Green Road, Ann Arbor, Michigan 48105.

10. Dixon, Wilfrid J. and Massey, Frank J. Jr.,: Introduction to Statistical Analyses; McGraw-Hill Book Co., Inc. 1957, pp. 81, 119, and 232.

11. Snedecor, G.W., Statistical Methods, Fifth Edition, P. 335, Iowa State University Press.

12. Journal of the American Hospital Association, Vol. 40, No. 15, Part 2, August 1966, Hospital Statistics, Hospitals, Facilities and Services 1965, Table 4, P. 466.

APPENDIX A

DIAGNOSIS GROUPINGS

Dx Group Code	ICDA* Code Numbers	English Title
1	002-138	Infective and parasitic diseases
2	140-205	Malignant neoplasms, all sites and types
3	210-239	Benign and unspecified neoplasms
4	240-289	Allergic, endocrine system, metabolic and nutritional diseases
5	290-299	Diseases of blood and blood-forming organs
6	300-329	Mental, psychoneurotic and personality disorders
7	330-398	Diseases of nervous system and sense organs
8	400-468	Diseases of circulatory system
9	470-527	Diseases of respiratory system
10	530-587	Diseases of digestive system
11	590-637	Diseases of genitourinary system
12	640-689	Deliveries and complications of pregnancy, childbirth, and puerperium
13	690-716	Diseases of skin and cellular tissue
14	720-749	Diseases of bones and organs of movement
15	750-759	Congenital Malformations
16	760-776	Certain diseases of early infancy
17	780-795	Symptoms, senility and ill-defined conditions
18	800-999	Injuries and adverse effects of chemical and other external causes
19	Y00-Y18	Special conditions and examinations without sickness
20	Y20-Y39	Births

* International Classification of Diseases, Adapted
Public Health Service Publication No. 719, Revised Edition
December 1962

APPENDIX B

APPROACHES TO UTILIZATION RATE CHANGES

The methods shown below for assessing this change use the following symbols: A_i=observed rate, B_i=adjusted rate using 1963 subgroup rates with subgroup discharges of "i"th year, C_i=adjusted rate using subgroup discharges of 1963 with subgroup discharges of 1963 with subgroup rates of "i"th year.

Relative increases in utilization rates are calculated as follows:

(1) $(A_i - A_{63})/A_{63}$ = relative increase (observed rates)

(2) $(A_i - B_i)/A_{63}$ or the arithmetic equivalent
$(C_i - A_{63})/A_{63}$ = relative increase (adjusted rates)

For example, using data from Table 17 for 1963 and 1966

(1) (513-463)/463=11% for the three year period

(2) (513-476)/463=8% for the three year period for age-adjusted rate

The observed change in overall utilization rates comprises two parts, one part attributable to population shifts, the other to changes in utilization rates. These parts are calculated as follows:

(1) $A_i - A_{63}$ = observed change in overall utilization rates, e.g., from Table 17, $A_{66} - A_{63}$ = 513-463=50

(2) $A_i - B_i$ = amount of rate change attributable to utilization rate changes, e.g., $A_{66} - B_{66}$ = 513-476=37

(3) $A_i - C_i$ = amount of rate change attributable to population shifts, e.g., $A_{66} - C_{66}$ = 513=500=13

Therefore, $(A_i - B_i)/(A_i - A_{63})$= proportion of total observed change attributable to utilization rates, e.g., from above, 37/50 = 74% of the change in total rates between 1963 and 1966 was attributed to utilization rate changes.

The ABSTRACT CARDS below are designed to facilitate document retrieval using Coordinate Indexing. They provide space for an accession number (to be filled in by the user), suggested keywords, bibliographic information, and an abstract.

The Coordinate Index concept of reference material filing is readily adaptable to a variety of filing systems. Coordinate Indexing is described in the publication "IBM Data Processing Techniques - Index Organization for Information Retrieval" (C 20-8062). Copies are available through IBM Branch Offices

The cards are furnished in triplicate to allow for flexibility in their use (for example, author card index, accession number card index).

F. M. Hemphill, Ph.D.; Frances B. Locke, M.S.; and Rudolph D. Hesselgren: DIAGNOSTIC RADIATION UTILIZATION IN SELECTED SHORT-TERM GENERAL HOSPITALS

Accession No.

U.S. Department of Health, Education, and Welfare, Public Health Service, Bureau of Radiological Health Publication No. BRH/DBE 70-8 (December 1970) 52 pp

ABSTRACT: To estimate trends of diagnostic medical radiation, two million patient hospital-stay records were studied annually for 1963, 1966, and 1968 from more than 200 selected general hospitals. The data on the utilization patterns of ten diagnostic radiation categories showed a significant annual increase of discharged patients who received any diagnostic radiation, and increased utilization of

(over)

F. M. Hemphill, Ph.D.; Frances B. Locke, M.S.; and Rudolph D. Hesselgren: DIAGNOSTIC RADIATION UTILIZATION IN SELECTED SHORT-TERM GENERAL HOSPITALS

Accession No.

U.S. Department of Health, Education, and Welfare, Public Health Service, Bureau of Radiological Health Publication No. BRH/DBE 70-8 (December 1970) 52 pp.

ABSTRACT: To estimate trends of diagnostic medical radiation, two million patient hospital-stay records were studied annually for 1963, 1966, and 1968 from more than 200 selected general hospitals. The data on the utilization patterns of ten diagnostic radiation categories showed a significant annual increase of discharged patients who received any diagnostic radiation, and increased utilization of

(over)

F. M. Hemphill, Ph.D.; Frances B. Locke, M.S.; and Rudolph D. Hesselgren: DIAGNOSTIC RADIATION UTILIZATION IN SELECTED SHORT-TERM GENERAL HOSPITALS

Accession No.

U.S. Department of Health, Education, and Welfare, Public Health Service, Bureau of Radiological Health Publication No. BRH/DBE 70-8 (December 1970) 52 pp.

ABSTRACT: To estimate trends of diagnostic medical radiation, two million patient hospital-stay records were studied annually for 1963, 1966, and 1968 from more than 200 selected general hospitals. The data on the utilization patterns of ten diagnostic radiation categories showed a significant annual increase of discharged patients who received any diagnostic radiation, and increased utilization of

multiple categories per discharge. Significant changes were found in utilization of specific radiation categories. Patterns of utilization differed markedly by age, discharge diagnosis, and hospital size. After adjustment for hospital population changes, utilization of any diagnostic radiation showed increases of 1% annually.
KEY WORDS: Diagnostic radiation utilization; diagnostic radiation trends; diagnostic radiation categories; hospital discharge population; radiation trends related to diagnosis

multiple categories per discharge. Significant changes were found in utilization of specific radiation categories. Patterns of utilization differed markedly by age, discharge diagnosis, and hospital size. After adjustment for hospital population changes, utilization of any diagnostic radiation showed increases of 1% annually.
KEY WORDS: Diagnostic radiation utilization; diagnostic radiation trends; diagnostic radiation categories; hospital discharge population; radiation trends related to diagnosis.

multiple categories per discharge. Significant changes were found in utilization of specific radiation categories. Patterns of utilization differed markedly by age, discharge diagnosis, and hospital size. After adjustment for hospital population changes, utilization of any diagnostic radiation showed increases of 1% annually.
KEY WORDS: Diagnostic radiation utilization; diagnostic radiation trends; diagnostic radiation categories; hospital discharge population; radiation trends related to diagnosis.

BIBLIOGRAPHIC DATA SHEET	1. Report No. BRH/DBE 70-8	2.	3. Recipient's Accession No.
4. Title and Subtitle Diagnostic Radiation Utilization in Selected Short-Term General Hospitals			5. Report Date December 1970 6.
7. Author(s) Fay M. Hemphill, Frances B. Locke, Rudolph D. Hesselgren			8. Performing Organization Rept. No. BRH/DBE 70-8
9. Performing Organization Name and Address U.S.D.H.E.W. P.H.S. Bureau of Radiological Health Division of Biological Effects 12720 Twinbrook Parkway Rockville, Md. 20852			10. Project/Task/Work Unit No. 11. Contract/Grant No.
12. Sponsoring Organization Name and Address			13. Type of Report & Period Covered 14.

15. Supplementary Notes

16. Abstracts

To estimate trends of diagnostic medical radiation, two million patient hospital-stay records were studied annually for 1963, 1966, and 1968 from more than 200 selected general hospitals. The data on the utilization patterns of ten diagnostic radiation categories showed a significant annual increase of discharged patienst who received any diagnostic radiation, and increased utilization of multiple categories per discharge. Significant changes were found in utilization of specific radiation categories. Patterns of utilization differed markedly by age, discharge diagnosis, and hospital size. After adjustment for hospital population changes, utilization of any diagnostic radiation showed increases of 1% annually.

17. Key Words and Document Analysis. 17a. Descriptors

17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Unlimited release.	UNCLASSIFIED	
	20. Security Class (This Page) UNCLASSIFIED	22. Price